Space Weather Technical Forecast

Issued on Wednesday 5 February 2025 at 13:21 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of glancing blows from two CMEs. Further M-class flares expected, slight chance of an X-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was moderate over the past 24 hours, with isolated M-class flares, most of which originated from AR3981. The strongest recorded was an M3.2 flare, peaking at 04/1313 UTC.

There are eight active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots in the north extending from central disc into the western hemisphere, and consisting of AR3976, AR3977, AR3978, AR3981and AR3984. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions. AR3976, AR3977, AR3978 appear to have shown little change recently, and AR3984 has shown slight decay. AR3981 to the rear of this cluster is by far the largest individual region and most active. It has two delta configurations within its complex and compact intermediate spots, with vertical shear evident, though is now beginning a slight decaying and splitting trend. The remaining spots are all small and simple, with AR3974 having now faded to plage.

No Earth directed CMEs (coronal mass ejections) were observed in available imagery in the past 24 hours. Though there is a chance of a glancing blow from a southwest filament eruption from early 05 Feb.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1, showed a generally flat trend ranging between an average of 370-430 km/s. Density was below average or average. The Interplanetary Magnetic Field, Bt, was weak, below 8nT. The north-south component, Bz, was largely positive and weak. Phi angle was positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels, peaking at 319 pfu. The associated 24-hour fluence persisted below the Active threshold, recording 9.15e6 integrated pfu at 05/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is forecast, with M-class flares expected at times and a slight chance of rising to High, with isolated X-class flares, primarily from the regions in the north spanning centre disc into the western hemisphere.

Solar Wind / Geomagnetic Activity: Two CMEs feature in the forecast, one from 02 Feb which may give a glancing blow with Earth on the morning of day 2 (06 Feb). Another from a filament eruption in the southwest early on 05 Feb, may possibly give a glancing blow late day 3 or day 4 (07/08 Feb). Both are low confidence. The potential for further CMEs and hidden transients is currently elevated.

Solar wind speeds are expected to continue generally at or near background levels for much of the period, but may return to slightly elevated or elevated levels should any CMEs arrive. The high speed stream of CH13/- is expected to most likely arrive at Earth beyond the current forecast period, although there is a chance it may become geoeffective later day 4 (08 Feb).

Generally Quiet (Kp 0-2) geomagnetic activity is expected for much of the period. However, there is a chance following any potential CME arrival early day 2 then late day 3 into day 4, of seeing activity temporarily increase to G1-G2/Minor-Moderate Geomagnetic Storm intervals (Kp 5-6). Also, later day 4 there is a slight chance for G1/Minor Storm conditions to develop should the next high speed stream arrive.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is likely to be at background levels, but with a slightly increasing potential of responding to any notable flares as the sunspot regions in the north move further into the western hemisphere. High energy electron flux observed at GOES16 has recently remained at Moderate levels. This is expected to persist, with a chance of becoming briefly diurnally High. The corresponding 24 hour fluence is expected to persist below the Active threshold.

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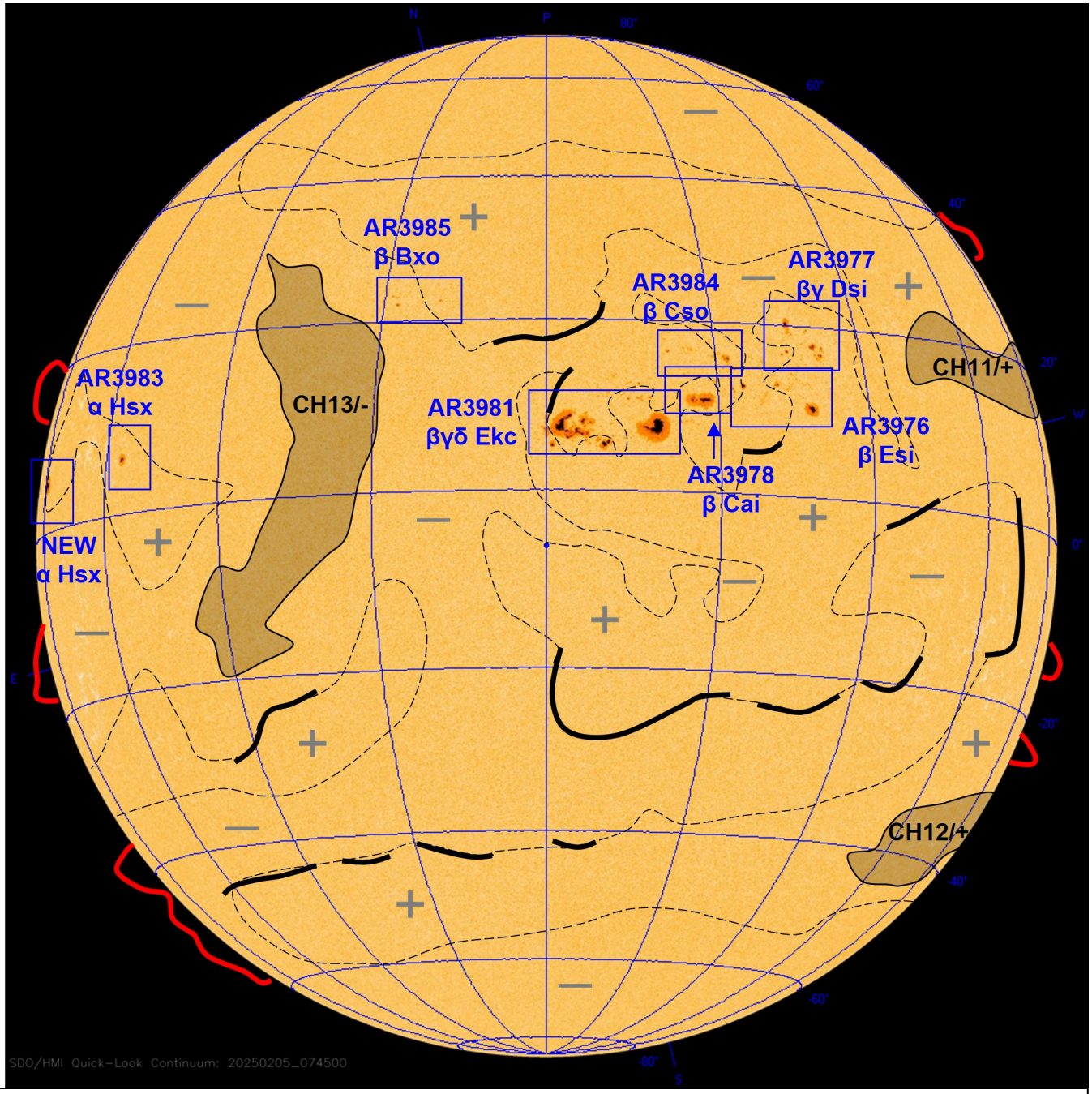
Figure 1: Solar Synoptic Map valid 05/0745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Two CMEs currently feature in the forecast, the first is a faint CME associated with an M4.1 flare at 02/2320 UTC from AR3981. This CME occurred at a similar time as a larger, far-sided CME, which lowers the confidence of analysis. However there is a possibility the CME could make a glancing impact with Earth on the morning of day 2 (06 Feb). The second CME is from a large filament eruption in the southwest early on 5th Feb. This CME has been analysed as a probable miss, but with a chance of a glancing blow any time from late on day 3 (07 Feb) until end of day 4 (08 Feb). Given the apparent amount of material which erupted from this filament, should it arrive at Earth it may lead to a moderately impactful event. The potential for further CMEs and hidden transients also remains elevated, with a number of large filaments in potentially geoeffective positions and the large cluster of the sunspots to the north giving frequent M flares.

Solar wind speeds have declined to near background, currently around 400km/s, following recent coronal hole connection. Solar wind speeds are expected to continue generally at or near background levels for much of the period, although could perhaps return to slightly elevated or elevated levels should either of the two CMEs arrive. The next recurrent feature will be the high speed stream of CH13/-. This is expected to most likely arrive at Earth on 09 Feb (beyond the current forecast period), although there is a chance it may become geoeffective later day 4 (08 Feb). MOSWOC ENLILs solar wind speeds are considered generally well modelled, but perhaps a little early with the onset of the next high speed stream.

Generally Quiet (Kp 0-2) geomagnetic activity is expected for much of the period. However, there is a chance following any potential CME arrival early day 2 then late day 3 into day 4, of seeing activity temporarily increase to G1-G2/Minor-Moderate Geomagnetic Storm intervals (Kp 5-6). Also, later day 4 there is a slight chance for G1/Minor Storm conditions to develop should the next high speed stream arrive.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	40	20	40
Strong	**G3**	No	1	5	1	5
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
03/0457	Partial	AR3981	NE	590	06/0700 +/- 6 hours	Chance of glancing impact, but low confidence.
05/07:00	Partial	Filament	SW	790	08/0000 +/- 6 hours	Chance of glancing impact.

Figure 2: MOSWOC ENLIL

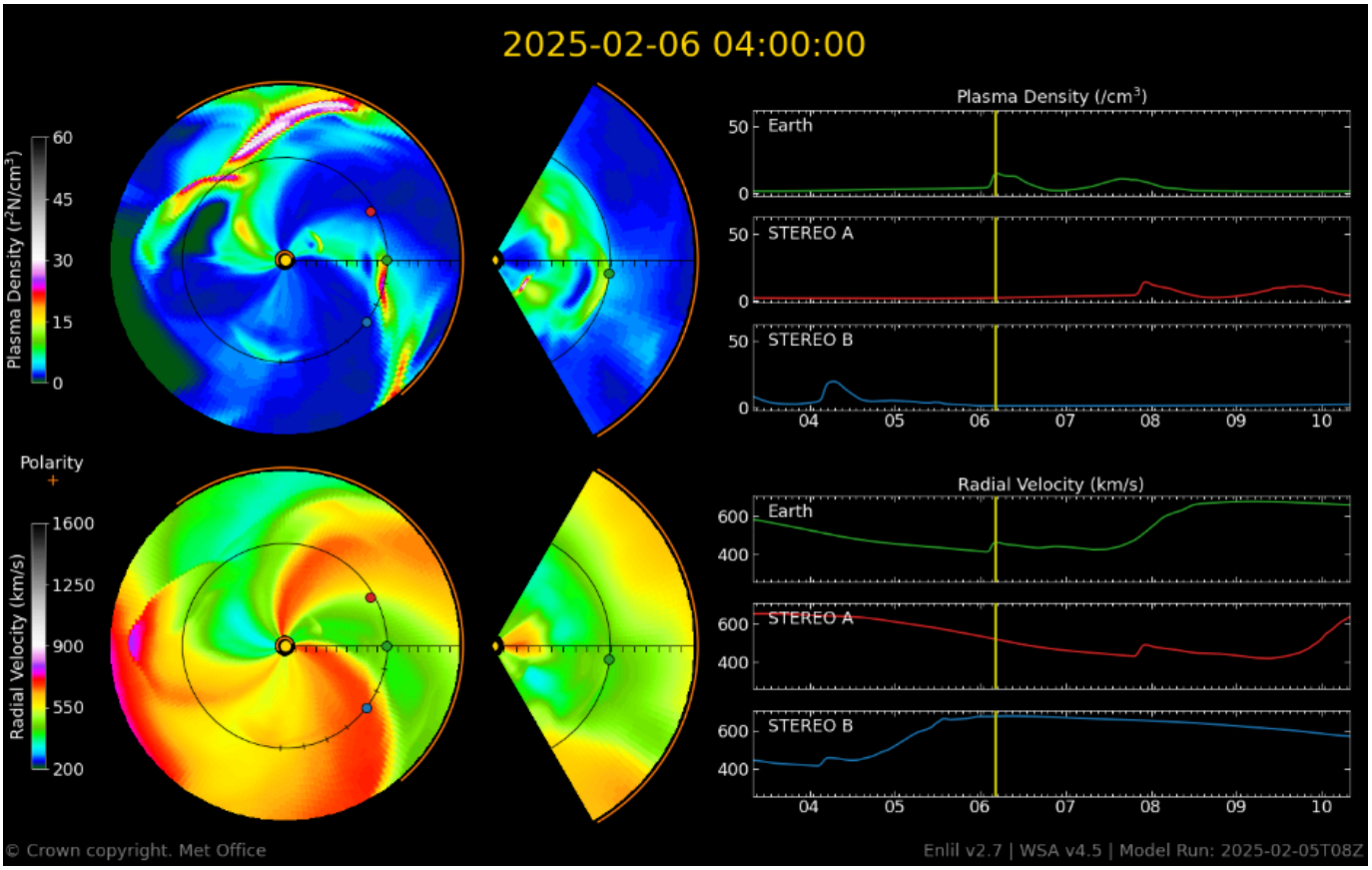

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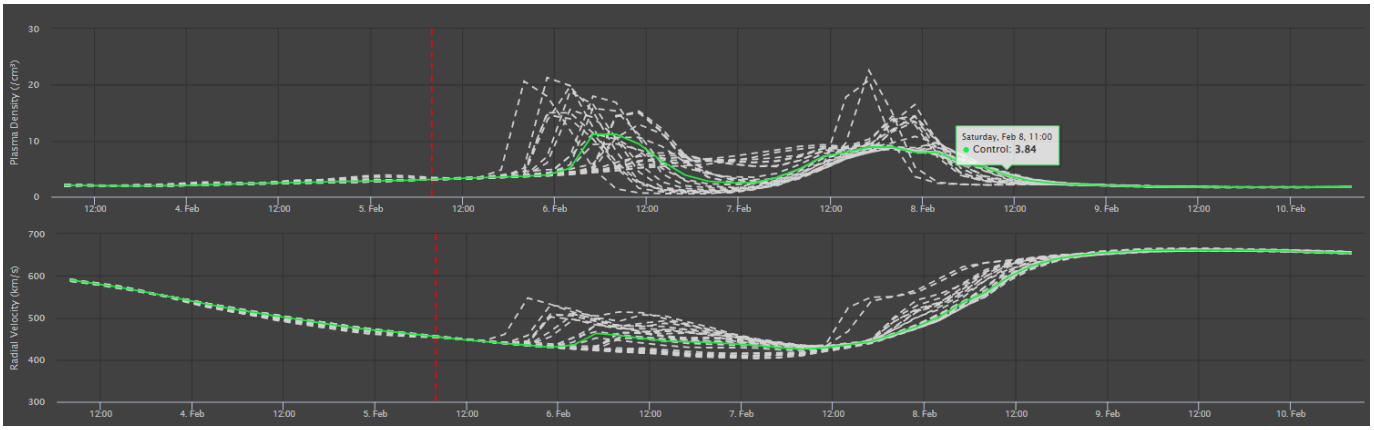
Figure 3: MOSWOC ENLIL ensemble.



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Radio Blackouts - X-Ray Flares

Solar activity was moderate over the past 24 hours, with occasional M-class flares, most of which originated from AR3981. The strongest recorded was an M3.2 flare, peaking at 04/1313 UTC.

There are eight active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots in the north extending from central disc into the western hemisphere, and consisting of AR3976, AR3977, AR3978, AR3981and AR3984. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions. AR3976, AR3977, AR3978 appear to have shown little change recently, and AR3984 has shown slight decay. AR3981 to the rear of this cluster is by far the largest individual region and most active. It has two delta configurations within its complex and compact intermediate spots, with vertical shear evident, though is now beginning a slight decaying and splitting trend. The remaining spots are all small and simple, with AR3974 having now faded to plage.

Further M-class flares are anticipated, primarily from AR3981, with a slight chance of an X-class flare.

No significant regions are due to rotate off the disc in the forecast period. Recurrence suggests the potential for returning regions during the period, although far-side helioseismic output has no strong signals in the short term.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	20	20	20	20

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Figure 4: 24 hour X-Ray trace

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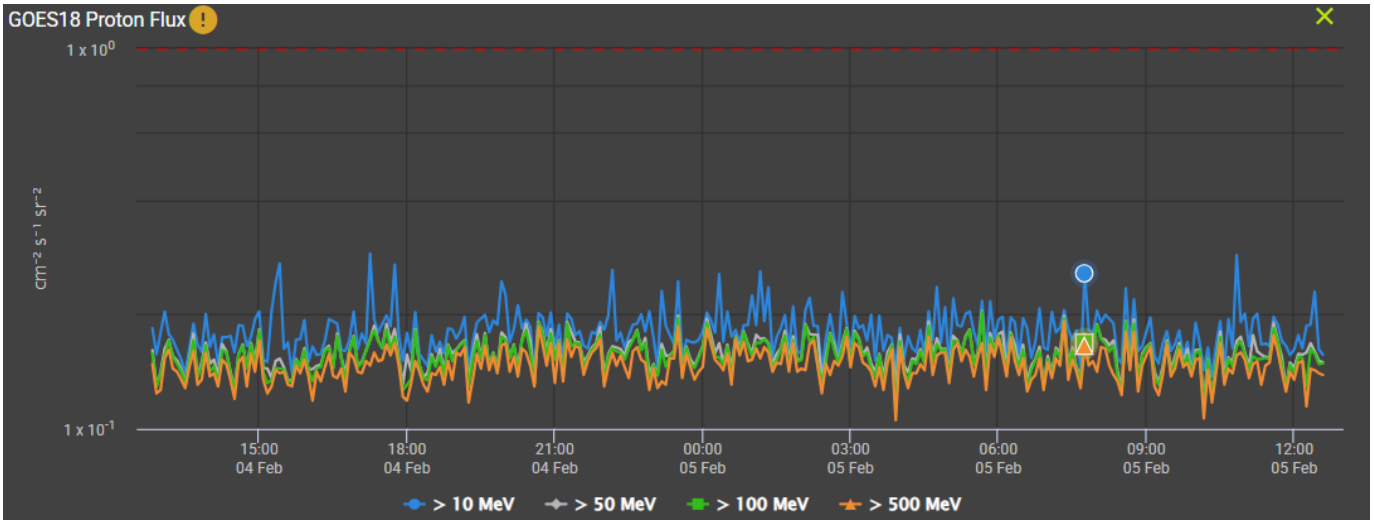
Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background levels, and is generally likely to remain that way, at least at first. As the large cluster of sunspots in the north move further across the western hemisphere, there is a gradually increasing chance of proton flux rising in response to any notable flares.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	25	30	30
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5:



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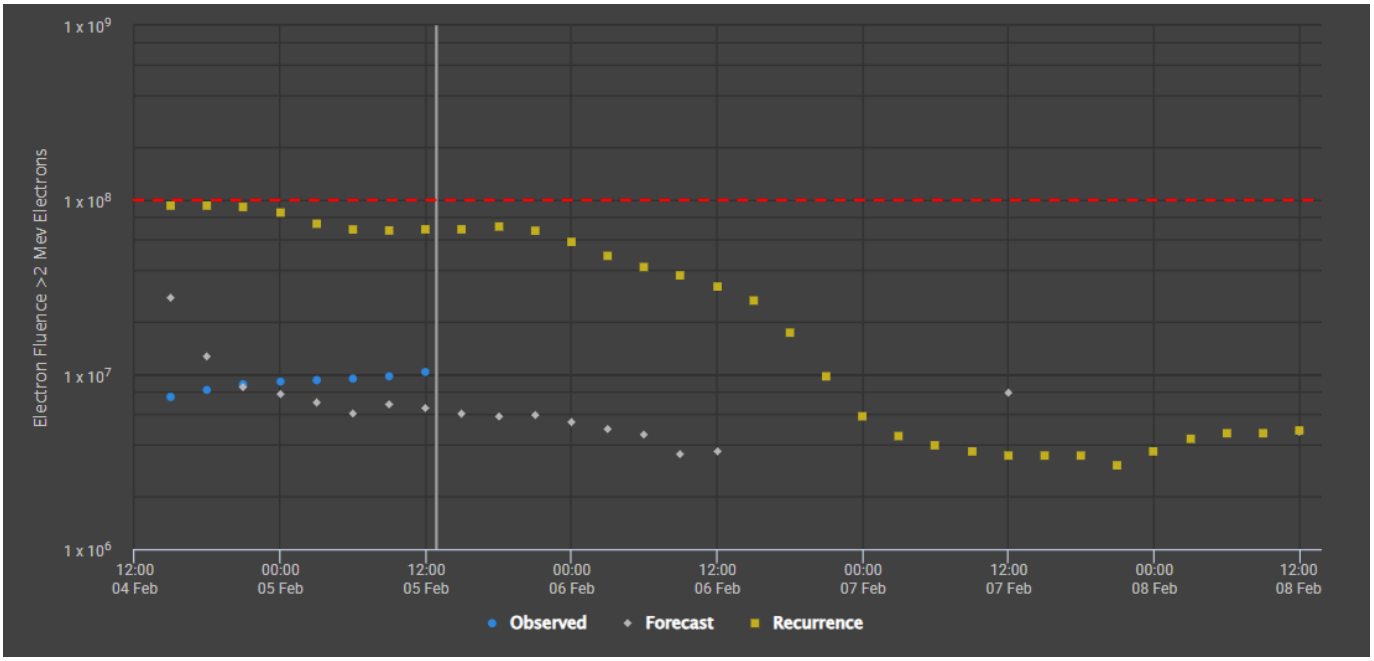
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has recently remained at Moderate levels. Given the lack of geomagnetic activity recently, the Van Allen belts are unlikely to be sufficiently charged to bring a dramatic increase in flux in coming days, with just a slight chance of becoming briefly diurnally High.

The corresponding 24 hour fluence is expected to persist below the Active threshold. MOSWOC REFM output is currently thought to be providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	5	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: REFM integrated flux/fluence forecast, observations and recurrence



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